STAFF PAPERS IN ECONOMICS

Agricultural Economics & Economics Dept

College of Agriculture
College of Letters and Science

Economic Feasibility of Small Wind Energy Generator Systems

Cathy Roheim, C. Robert Taylor and Myles Watts

Staff Paper 85-1

Montana State University, Bozeman

STAFF PAPERS IN ECONOMICS

Agricultural Economics & Economics Dept

College of Agriculture
College of Letters and Science

Economic Feasibility of Small Wind Energy Generator Systems

Cathy Roheim, C. Robert Taylor and Myles Watts

Staff Paper 85-1

Montana State University, Bozeman

Economic Feasibility of Small Wind Energy Generator Systems

Cathy Roheim, C. Robert Taylor and Myles Watts

Staff Paper 85-1

ECONOMIC FEASIBILITY OF SMALL WIND ENERGY GENERATION SYSTEMS*

Cathy Roheim, C. Robert Taylor, and Myles J. Watts**

INTRODUCTION

This report presents estimates of the economic feasibility of generation of electricity by a small wind energy conversion system (SWECS) in Montana. Estimates are given for various assumptions about the properties of the machine and its performance, wind speeds in Montana, price received for electricity generated, purchase price of the machine, marginal Federal and State income tax rates, available tax credits, and depreciation allowances. Any one of these technical and economic variables can determine whether a particular SWECS installation is profitable. Scenarios considered in the report cover a wide variety of situations that might be encountered by a potential SWECS investor in Montana; nevertheless, a potential investor should calculate the benefits and costs of each potential investment considering wind speed, expected performance of the machine, expected price and his or her own tax bracket.

Under the Federal Public Utilities Regulatory Policy Act (PURPA) of 1978, public utilities are mandated to buy-back electricity generated from SWECS. In addition, the utilities are required to pay a price equal to the "avoided cost," defined to be the incremental costs to an electric utility of additional electric energy or of additional generation capacity. The avoided cost is not a national figure, but a cost based on conditions faced

---

*The analysis reported in this paper was supported in large part by a grant #WDG-84-5012 from the Montana Department of Natural Resources and Conservation.
**Graduate Research Assistant, Professor, and Associate Professor, respectively, Department of Agricultural Economics and Economics, Montana State University.

by the relevant local electrical utility. Thus the avoided cost or buy-back price can vary between Montana and, say California, and also vary within Montana.

Public utility pricing policy requires utilities to price electricity to their retail customers at the "average cost"; under current economic conditions in some parts of the state, this average cost is below the avoided cost. Thus some utilities must buy electricity generated from SWECS at a rate that exceeds the rate charged to many residential and commercial companies. In such a situation, it is more profitable for a SWECS investor to sell all electricity generated to the public utility at the avoided cost rate, and purchase any electricity required for a residence, farm, or business at the average cost rate. In the analysis that follows, the price of electricity should be set equal to the avoided cost price for a firm that sells all generated electricity to the utility. On the other hand, if all electricity generated is used on farm, the price should be set equal to the purchase price for electricity. Finally, for a situation where electricity is bought and sold (i.e., the meter is run both directions) an average or blended price should be used in the analysis.

The first section of this report presents the characteristics of the representative wind machine used for this study. In the second section, the economic variables included in the analysis and their application to the problem are explained. The third section presents the net present value benefit assessment framework, while the fourth section discusses values of the primary economic parameters used in the analysis. Presented next are the net present value profit estimates and conclusions of the study. A FORTRAN computer program that can be used for economic analysis of SWECS is presented in an Appendix.

CHARACTERISTICS OF THE MACHINE

The representative SWECS used for this analysis has a Jacobs design in which there are three horizontal blades, 23 feet in diameter with yaw control to direct the blades in an optimal position with wind direction. Machines of this common type are used in Montana. Technical data on various brands of SWECS can be found in The Montana Renewable Energy Handbook, pages 45-56.

Three levels of annual energy output from the 10kw machine were assumed; these were 10,000, 17,500, and 25,000 kwh/year. Assuming validity of the energy graph in Figure 1 and no down time, the above energy output levels can be generated from average wind speeds of approximately 9.0, 11.8, and 15.0 mph, respectively. Average wind speeds in this range are found in many Montana locations, particularly on the eastern slopes of the Rocky Mountains. Average wind speed data for eleven major Montana cities are given in Table 1. It should be noted that average wind speeds may vary considerably from one location to the next, depending on geographical location, topographical features, and other factors. Thus, wind characteristics at particular sites should be considered by potential SWECS investors.

The total cost of the machine and installation at the time this report was prepared was $22,630.00, itemized as follows:

Generator (23' diameter, 10kw peak output)	$12,995.
Inverter	included
100 ft. tilt-up tower	5,400.
Electrical hardware and wiring	1,350.
Kilowatt-hour meter	60.
Excavation and concrete	950.
Labor (installation and wiring hook-up)	1,875.
TOTAL	$22,630.

Actual costs may differ from the above figures due to changing prices, distance of the installation site from the shipping point, and for different

brand machines. Due to these possible cost differences, the economic analysis in this study was done for total costs of $20,000, $23,000, and $25,500, including the cost of installation.

ECONOMIC ANALYSIS FRAMEWORK

Due to substantial Federal energy and investment tax credits that can be claimed with a SWECS investment, tax considerations are of considerable importance in any analysis of the profitability of SWECS. Thus the focus of this analysis is on these tax considerations and the after-tax profitability of SWECS. For comparative purposes and for completeness, before-tax profitability estimates are also given. Tax computations were based on 1984 laws, which may change in future years. This section of the report presents the formula used in calculating the new present value benefits (after-tax and before-tax) of SWECS.

With current technology, most SWECS have an economic life of at least twenty years. Since benefits and costs accrue over time, a present value calculation is used to bring all future benefits and costs back to the current period. Future benefits and costs are "discounted" to reflect the fact that a dollar at some point in the future is not worth as much as a dollar at the present time.

Although the analysis is done in "real" terms net of inflation, it is necessary to specify the inflation rate because of its interaction with depreciation of SWECS for tax purposes. That is, the amount of the SWECS cost that can be written off tax returns in any given year depends on initial cost, while benefits are tied in with inflation except in the case of a long term contract for electricity generated. Thus, inflation drives a tax wedge between benefits and depreciation of SWECS, and must be considered in an analysis of the type done in this study.

Before tax analysis framework

The before tax net present value return associated with a SWECS was computed as,

$$NPV = NPVGR - COST - NPVOM$$

where NPV is the net present value return from the SWECS, NPVGR is the net present value of gross revenue, COST is the cost of purchasing and installing the machine, and NPVOM is the net present value cost of operating and maintaining the machine. NPVGR was computed by multiplying expected yearly gross revenue by an annuity discount factor that accounts for life of the machine, the discount rate, and the expected escalation rate for revenue. The specific formula to calculate the annuity discount factor for before tax gross revenue (ADFBTR) is,

$$ADFBTR = \{1 - (1 + r')^{-I}\}/r'$$

where I is the life of the machine in years, and

$$r' = -1 + \{1+nombt\}/\{1+esc\}$$

where nombt is the nominal before tax discount rate and esc is the escalation rate applied to gross revenue.

The annuity discount factor applied to operating and maintenance costs (ADFOM) is calculated as

$$ADFOM = \{1 - (1 + r'')^{-I}\}/r''$$

where

$$r'' = -1 + \{1 + nombt\}/\{1 + inf\}$$

where inf is the expected inflation rate. The inflation rate was used in this annuity discount factor because we expect costs to be affected by inflation, which is not necessarily the same as the expected escalation rate for revenue which is used in the annuity discount factor for revenue.

After tax analysis framework

The net present value after tax return associated with a SWECS was computed as,

$$NPVAT = NPVGRA - NPVOMA - COST + TAXCR + NPVDEP$$

where NPVAT is the net present value after tax return, NPVGRA is the net present value after tax revenue generated by the machine, NPVOMA is the net present value operations and maintenance cost, COST is the initial cost of maintaining and installing the machine, TAXCR is the investment and energy tax credits that can be obtained, and NPVDEP is the net present value tax benefit associated with tax depreciation of the investment. The latter item is a benefit rather than a cost because it reduces the taxable income of the investor, thereby reducing taxes paid by the investor.

Net present values of revenues and operating and maintenance costs were computed by taking the product of an annuity discount factor and yearly revenue or cost, respectively. The after tax annuity discount factors differ from before tax discount factors only in that the marginal tax rate influences the factor. The after tax annuity discount factor applied to gross revenue (ADFATR) was calculated as,

$$ADFATR = \{1 - (1+i')^{-I}\}/i'$$

where

$$i' = \{1+nombt(1-margtr)\}/\{1+esc\}-1$$

where margtr is the marginal (combined Federal and State) tax rate applied to ordinary income, and the other terms are as previously defined.

The after tax annuity discount factor applied to operating and maintenance costs (ADFOMAT) was defined as follows,

$$ADFOMAT = \{1-(1+i'')^{-I}\}/i''$$

where

$i'' = -1 + \{1+nombt(1-margtr)\}/\{1+inf\}$

The annuity discount factors given above are multiplied by their respective constant yearly revenue or cost figures to give present value. For instance, if revenue is expected to be the price paid for electricity by the utility times the amount of electricity generated for the year by the machine, assumed constant or perhaps averaged over the life of the machine, then the annuity discount factor for revenue is multiplied by the revenue to determine present value. A numerical example may clarify this point. Consider the following data:

Expected life of machine = 20 years

Expected inflation rate = 7 percent

Escalation rate = 7.5 percent

Nominal before tax discount rate = 12 percent

Energy generated each year = 25000kwh

Price received for electricity = $.0525

Marginal tax rate = 30 percent

The before tax annuity discount rate applied to revenue is ADFBTR = 13.3691 and the after tax annuity discount factor applied to revenue is ADFATR = 18.3448. Therefore, NPVGR = (13.3691)($0.0525)(25000kwh/year) = 17547.01 is the present value of before tax gross revenue over the 20 year life of the SWECS; the after tax present value of gross revenue is NPVGRA = (18.3448)($0.0525)(0.7)(25000kwh/year) = $16854.32. The same type of analysis is applied to present value calculations for operations and maintenance costs over the life of the machine.

The net present value of tax benefits associated with tax depreciation of the investment was calculated as

$NPVDEP = dep(i)/\{1+nombt(1-margtr)\}$

where i is the year in which the depreciation is taken on the tax return.

Note that financing the wind machine does not enter into the above analysis. It was not entered because it can be shown that if the discount rate required on the loan is equal to the nominal before tax discount rate, then the net present value of the loan payments equals the loan balance, effectively cancelling out the effect of financing on the analysis. Therefore, the present value of the loan has no effect on the net present value of the SWECS machine under this assumption.

Cash flow considerations, in addition to present value considerations, are also important to some potential SWECS investors. Cash flow computations were done for both before tax revenues and costs and after tax revenues and costs; future benefits and costs are shown in current dollars in analyses that follow.

ECONOMIC PARAMETERS

The 1984 Federal tax law allows for an investment tax credit equal to 10 percent of the initial cost of the SWECS; in addition, energy tax laws allow for an additional energy tax credit equal to 15 percent of initial cost. The combined effect of these two tax credits is to reduce the investor's tax liability by a maximum of 25 percent of the initial cost of the SWECS in the year in which investment occurs.

A word of explanation is also needed for the Montana tax credit used. Initially it was thought that the 35 percent energy tax credit was applicable to this type of situation in which a business such as a farm or ranch invested in a wind machine. However, this credit, while it could apply given certain events, is not necessarily the best state tax credit for the SWECS investor to take. The Montana energy tax credit for commercial investments in wind systems is defined to be 35 percent of taxable or net income produced only by the following: (1) manufacturing plants located in

Montana that produce wind energy generating equipment; (2) new or expanding businesses that purchase wind-generating electricity on a direct sale contract to meet their power needs; or (3) the wind energy generation equipment for which credit is being claimed. Note that the State tax credit is for net income and not initial cost as with the Federal tax credit.

In addition to the above requirements, there must be at least a $5000.00 capital investment to claim a credit to reduce the investor's State income tax (Source: Montana Energy Tax Benefits, DNRCF, Jan. 1984). Given this definition, a farm or ranch which installs a SWECS must produce a profit (i.e. the revenue from electricity generated must be greater than the deductible expenses incurred) within the first seven years after installation of the machine. For the economic and technical situations considered in this report, returns for electricity generated will not exceed the deductible expenses in the first seven years. Therefore, analyses in this report are based on a State investment credit equal to 5 percent of the total Federal investment credits allowed up to a maximum of $500.00 tax credit.

Depreciation to the machine was assumed to follow the ACRS (accelerated cost recovery system) for 5-year property. Even though the SWECS has an expected life of at least 20 years, it appears that the investment will qualify for ACRS. The depreciable basis of the machine is taken to be the cost of installation minus 50 percent of the Federal tax credit allowed. The percentage of the depreciable basis taken each year over the five years are 15 percent for the first year, 22 percent the second year, and 21 percent for each of the next three years.

RESULTS

An economic analysis was conducted for a variety of assumptions regarding cost of the SWECS machine ($20,000.00, $23,000.00, and $25,500.00), price received for electricity generated ($0.0525, $0.65, and $0.08), electricity generated (10,000kwh, 17,500kwh, and 25,000kwh/year), and marginal combined Federal and State marginal tax rates (30%, 40%, and 50%). Net present value before tax returns and net present value after tax returns for these scenarios are graphically shown in figures 1 through 9. From these figures, it can be seen that tax considerations make SWECS economically more attractive to investors; however, a positive net present value (i.e. profit) is obtained only under very favorable tax, price, and wind conditions.

References

Montana Department of Natural Resources and Conservation. *The Montana Renewable Energy Handbook*, May 1981.

Montana Department of Natural Resources and Conservation. *Montana Energy Tax Benefits*, January 1984.

Table 1. Annual Wind Information for Major Montana Cities

	Average Wind Speed (mph)
Billings	11.65
Cut Bank	12.60
Dillon	9.10
Great Falls	12.40
Havre	10.40
Helena	7.90
Kalispell	6.90
Lewistown	10.10
Livingston	14.10
Miles City	10.80
Missoula	6.50

Source: Robert Harrington, Mechanical Engineering Department, Montana State University, 1978.

FIGURE 1. ESTIMATED NET PRESENT VALUE RETURNS FOR A LOW COST MACHINE AND A 30% MARGINAL TAX BRACKET

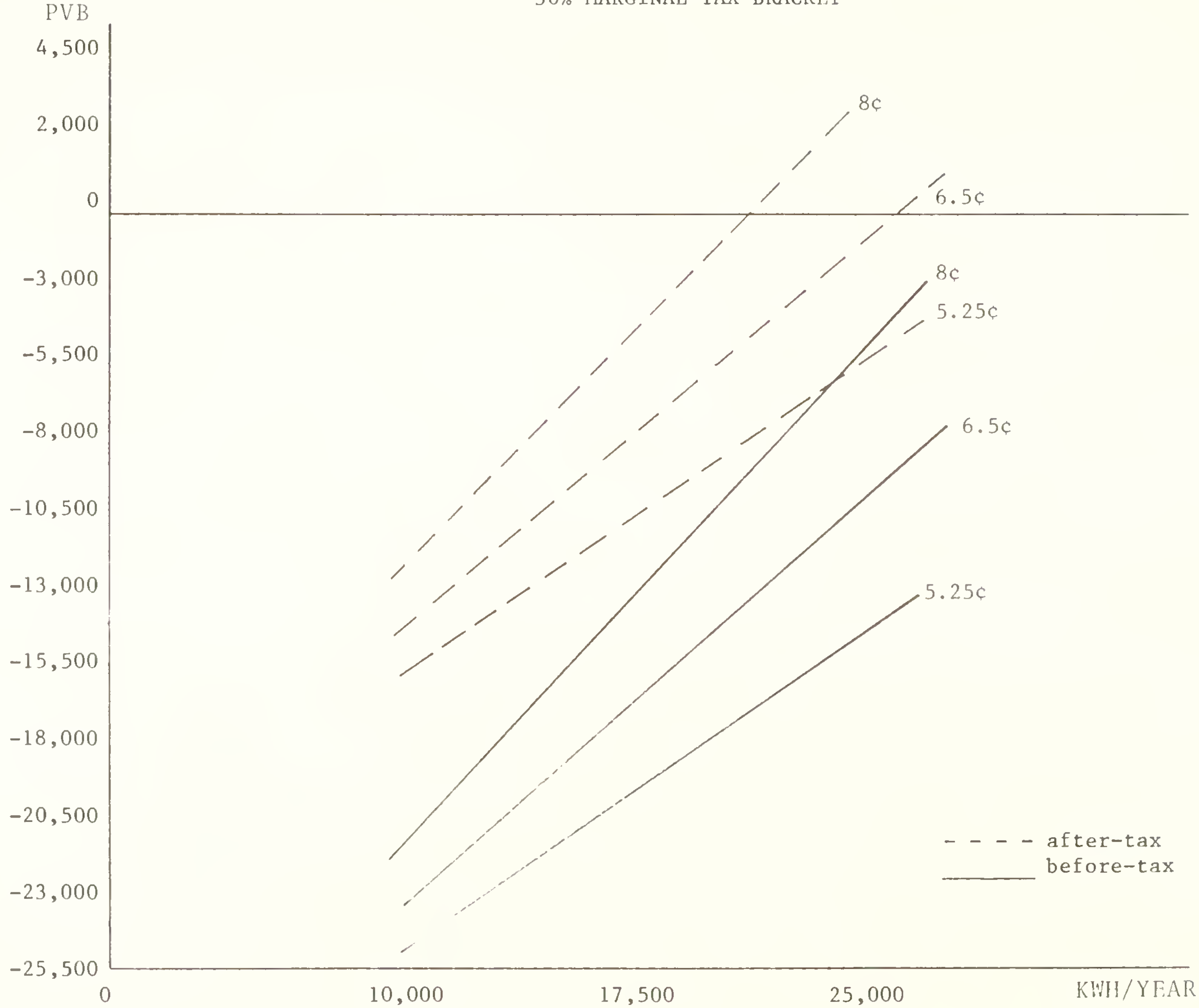


FIGURE 2. ESTIMATED NET PRESENT VALUE RETURNS FOR A LOW COST MACHINE AND A 40% MARGINAL TAX BRACKET

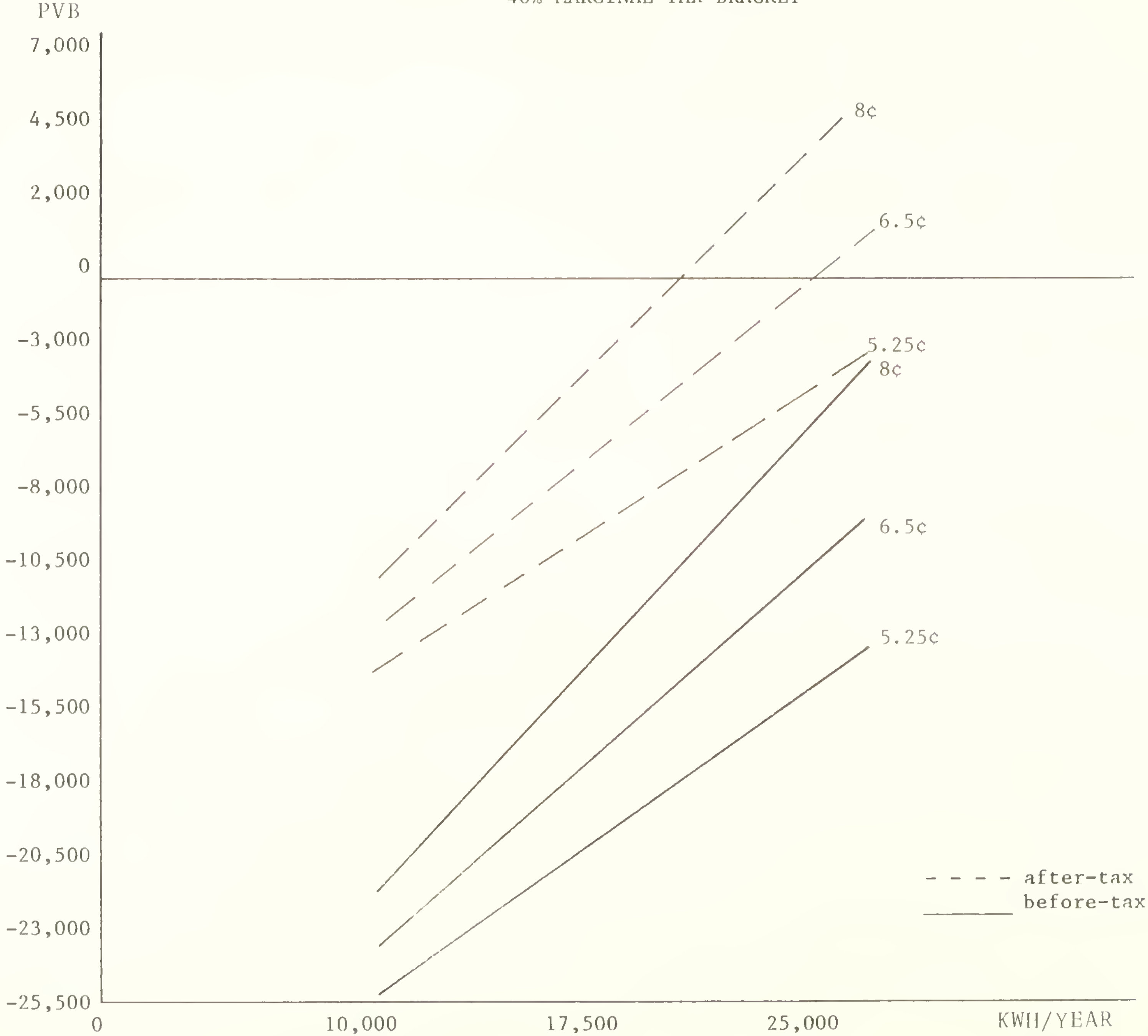


FIGURE 3. ESTIMATED NET PRESENT VALUE RETURNS FOR A LOW COST MACHINE AND A 50% MARGINAL TAX BRACKET

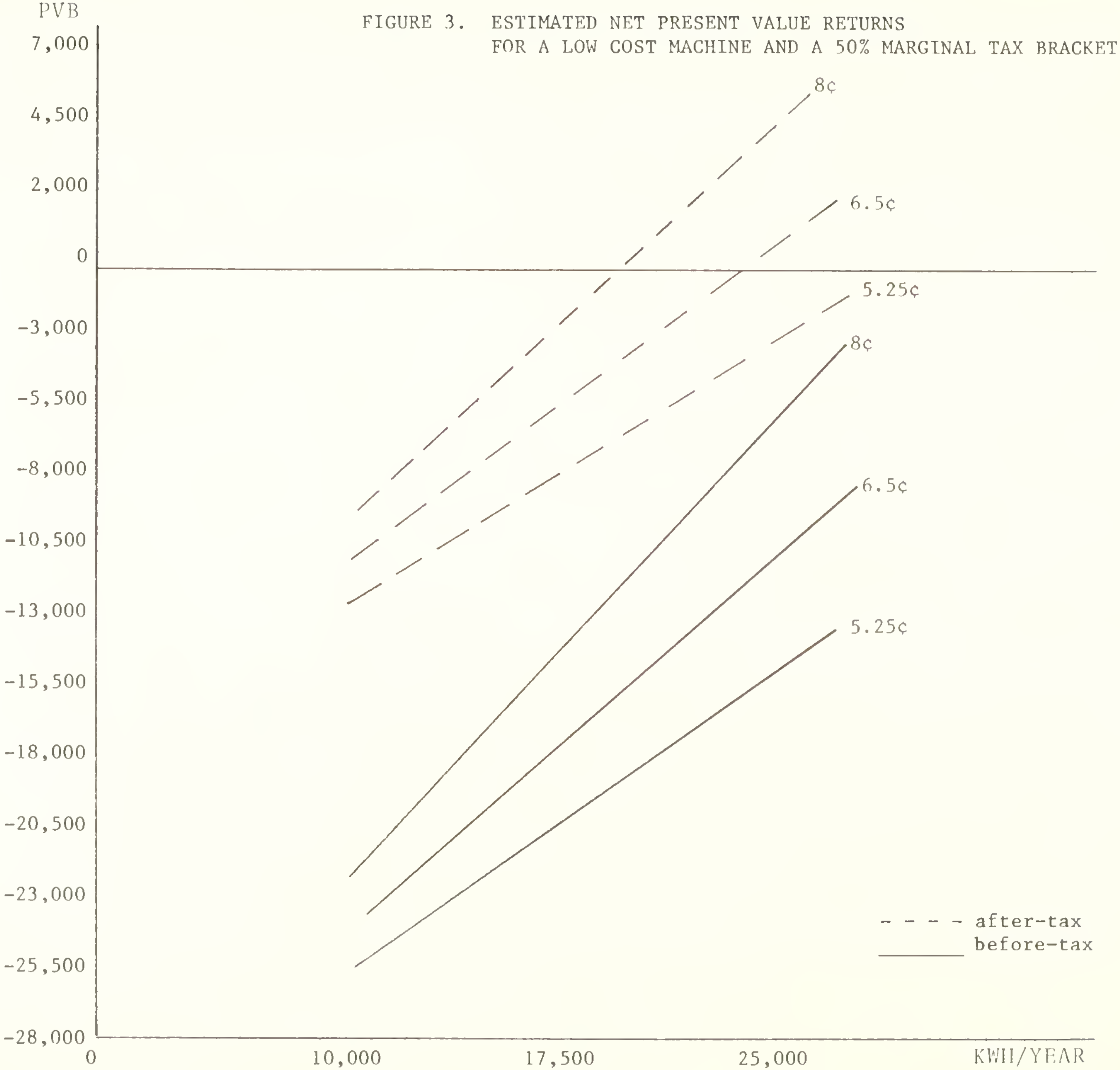


FIGURE 4. ESTIMATED NET PRESENT VALUE RETURNS FOR A MEDIUM COST MACHINE AND A 30% MARGINAL TAX BRACKET.

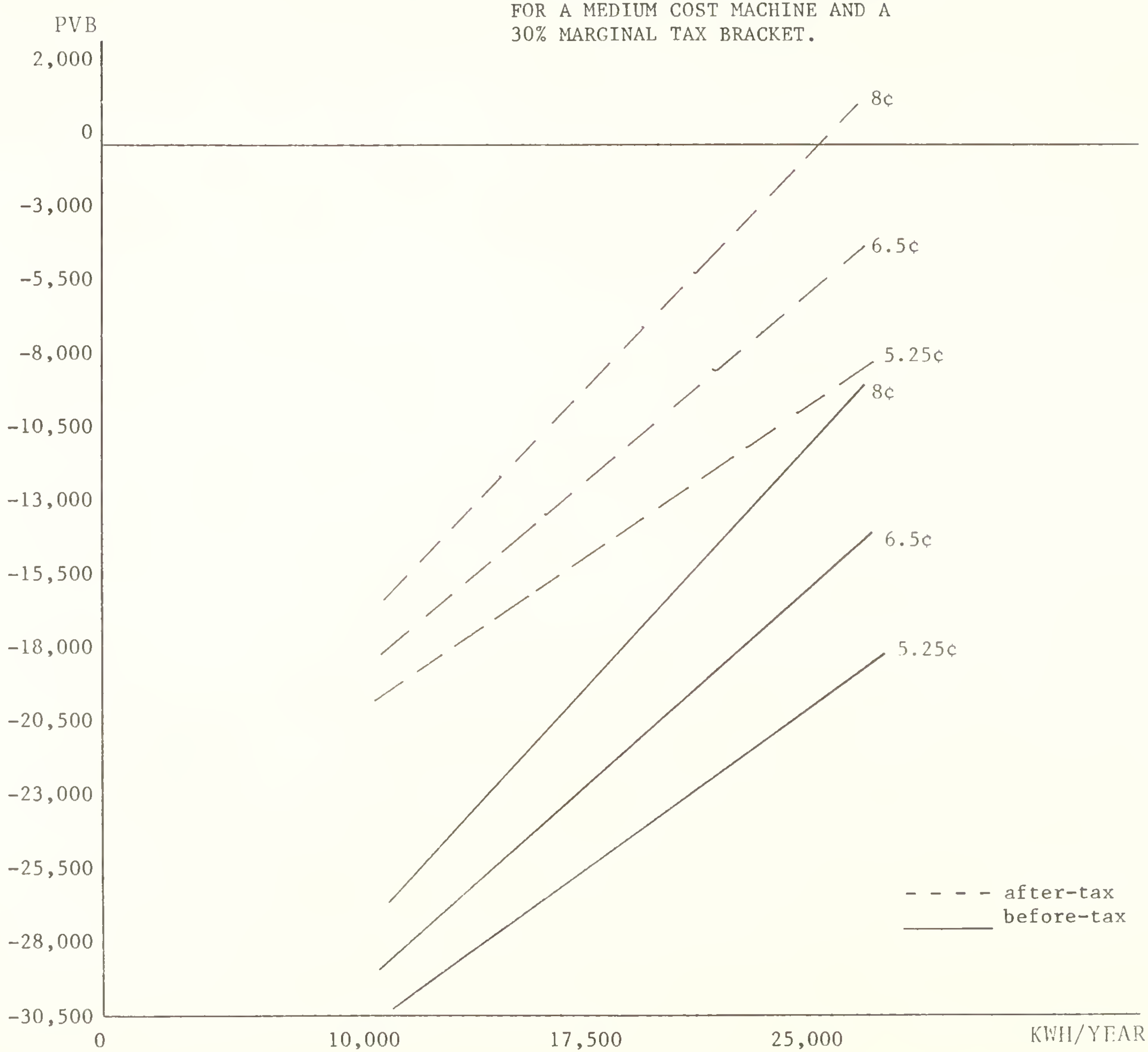


FIGURE 5. ESTIMATED NET PRESENT VALUE RETURNS FOR A MEDIUM COST MACHINE AND A 40% MARGINAL TAX BRACKET

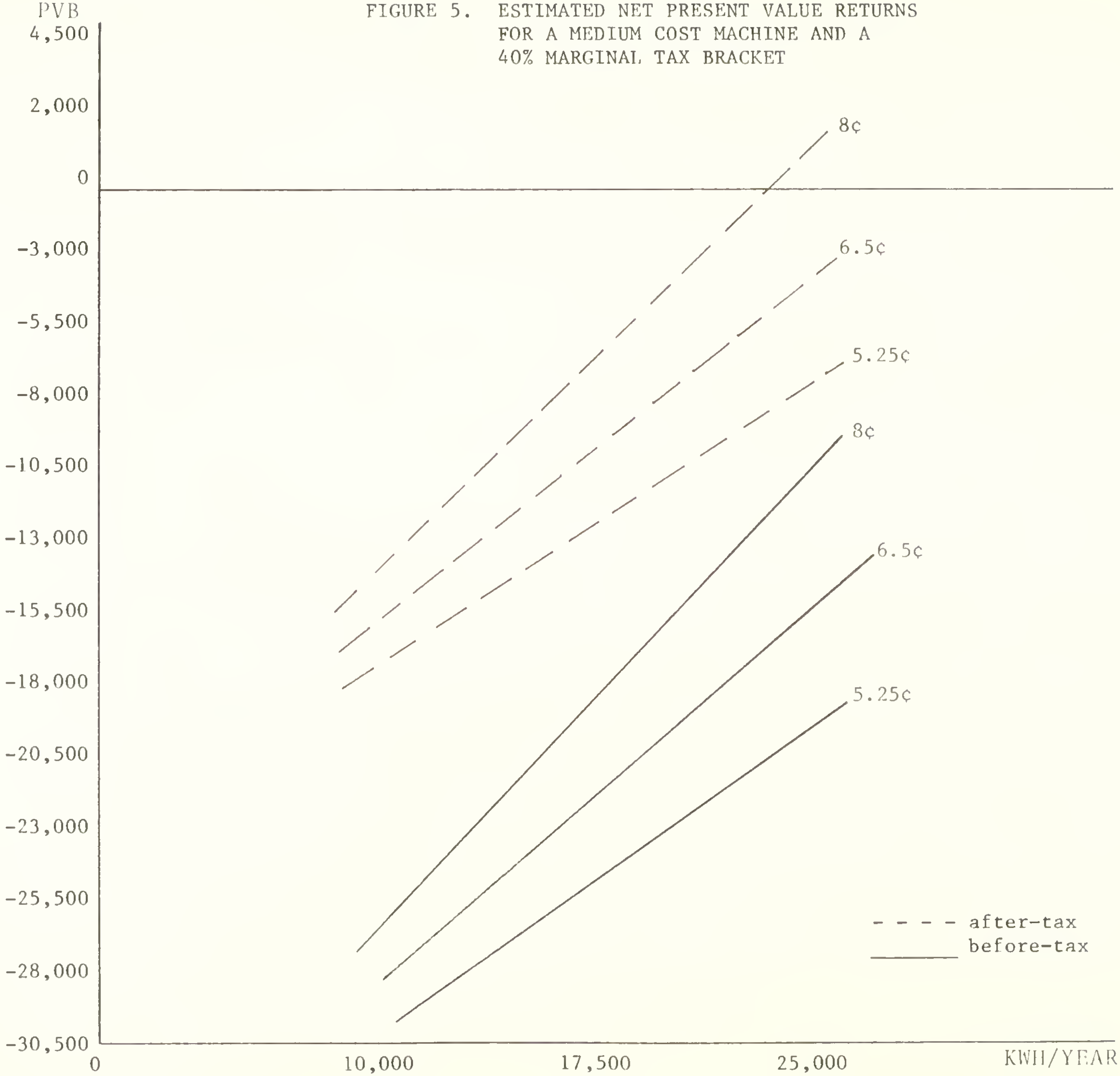


FIGURE 6. ESTIMATED NET PRESENT VALUE RETURNS FOR A MEDIUM COST MACHINE AND A 50% MARGINAL TAX BRACKET

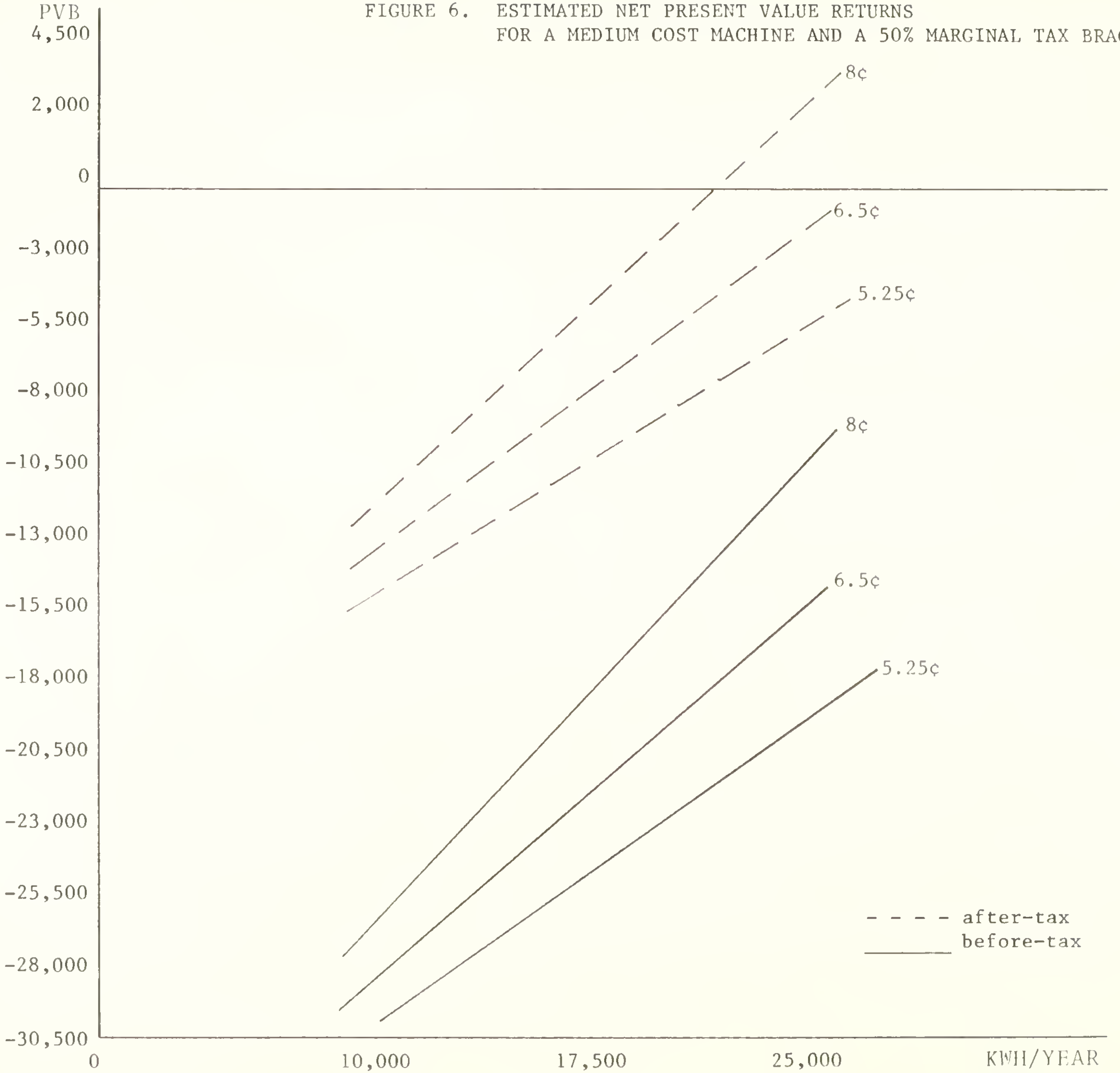


FIGURE 7. ESTIMATED NET PRESENT VALUE RETURNS FOR A HIGH COST MACHINE AND A 30% MARGINAL TAX BRACKET.

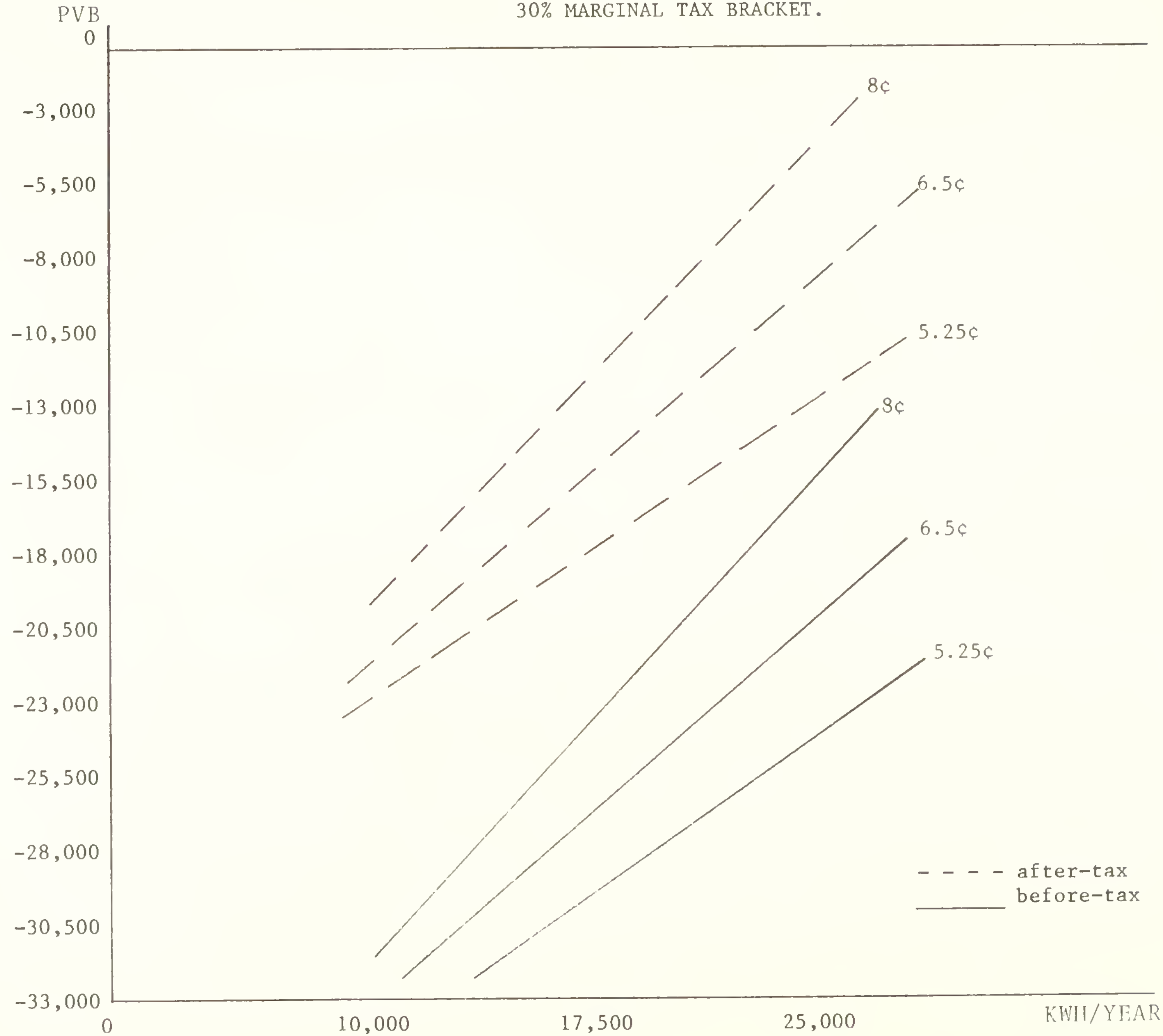


FIGURE 8. ESTIMATED NET PRESENT VALUE RETURNS FOR A HIGH COST MACHINE AND A 40% MARGINAL TAX BRACKET

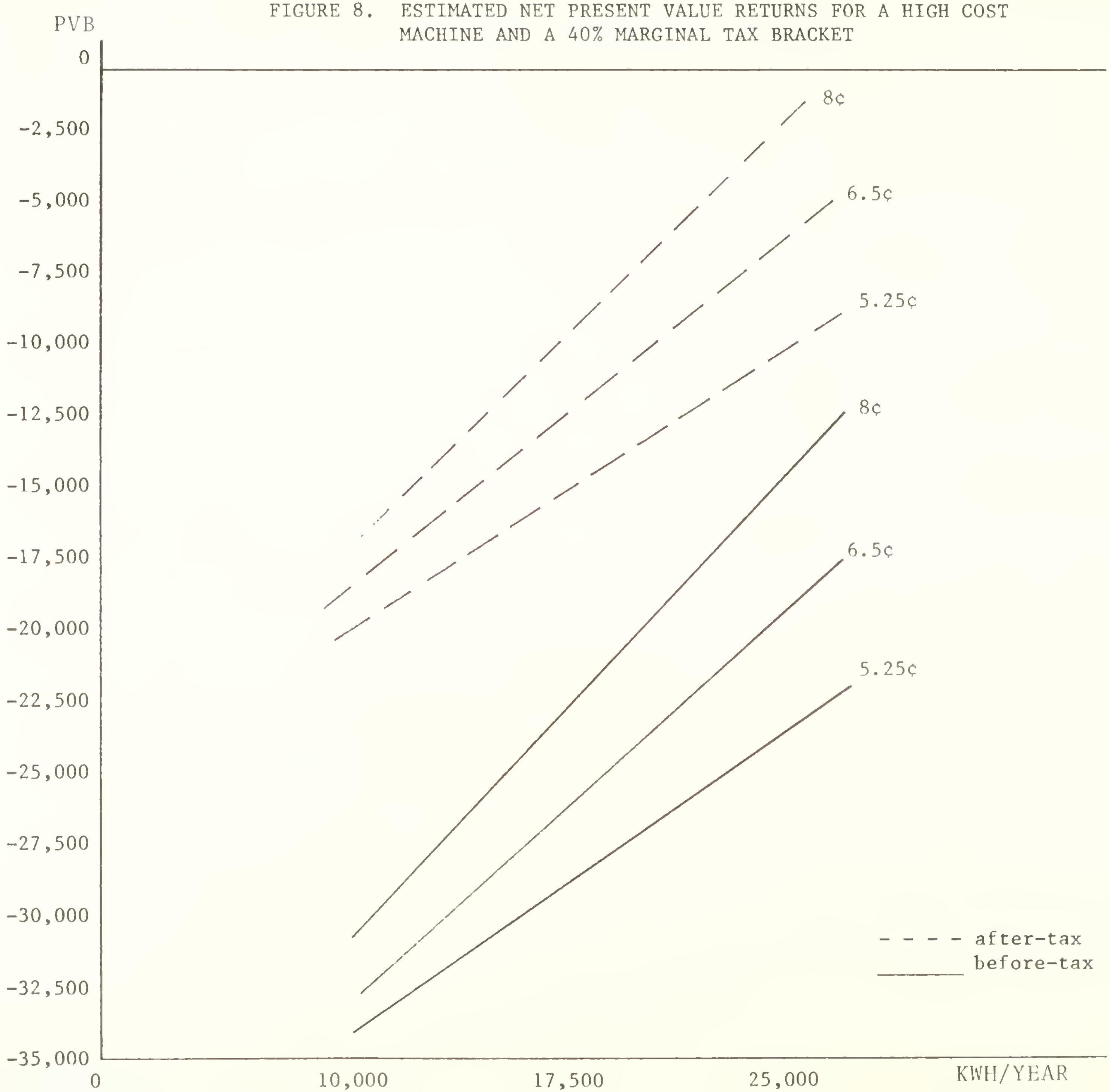
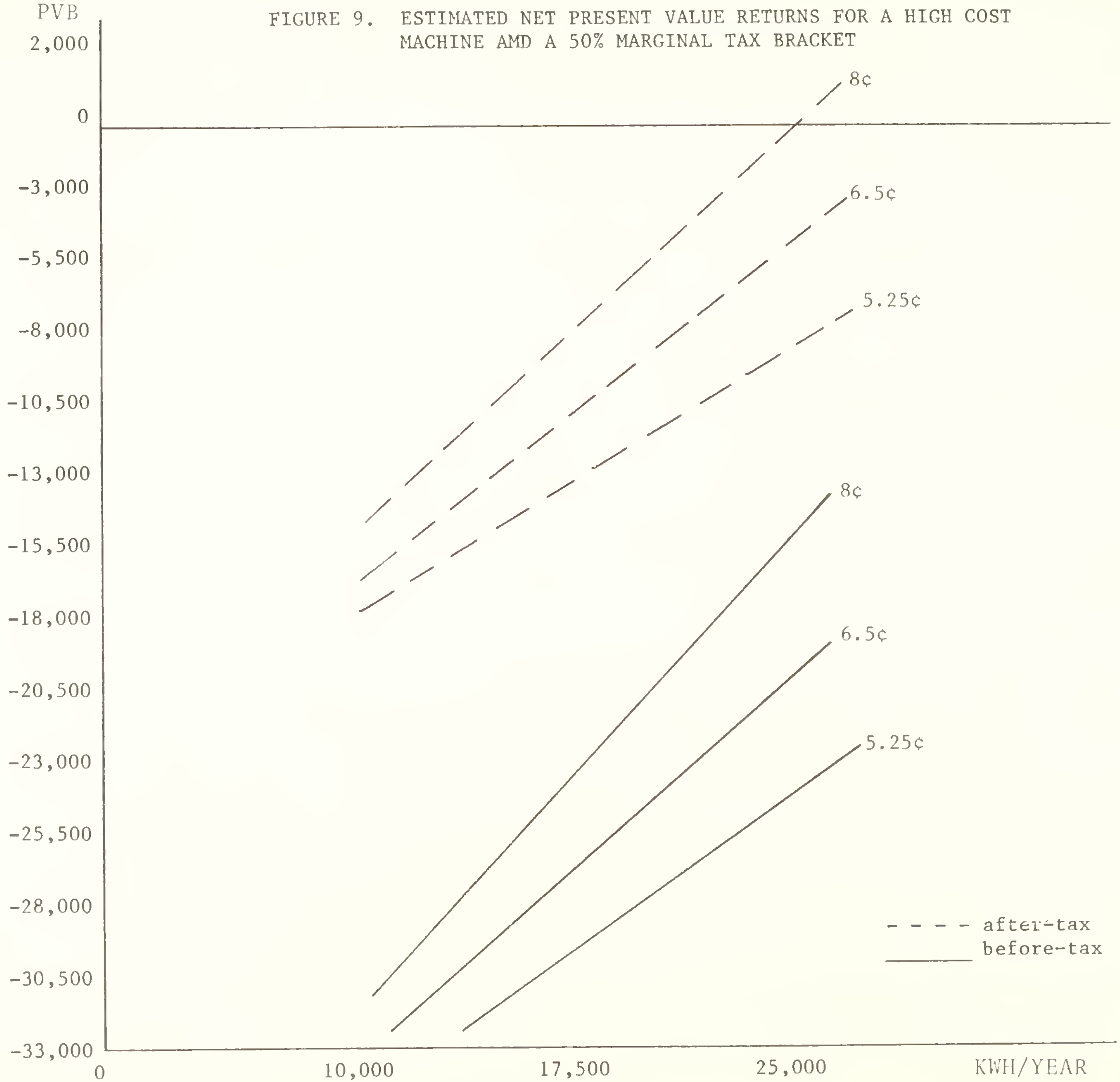


FIGURE 9. ESTIMATED NET PRESENT VALUE RETURNS FOR A HIGH COST MACHINE AMD A 50% MARGINAL TAX BRACKET



Appendix A

FORTRAN Program for Benefit-cost Analysis of SWECS

```
      IMPLICIT REAL(A-Z)
      DIMENSION X(14),OMC(30),D(30),R(30),PVD(30),CF(30)
     *,RR(30),RCFT(30),C(30)
      INTEGER LIFE,I,J
      COMMON LIFE
      OPEN(5,FILE='WIND.DAT')
      OPEN(6,FILE='WIND.LIS')
      READ(5,1) (X(J),J=1,14)
    1 FORMAT(F3.0,2F9.2,5F6.3/F6.3,F12.2,F7.3,2F9.2,F6.3)
C
C
C     EXPECTED LIFE OF WIND MACHINE(YEARS)
      LIFE=IFIX(X(1))
C
C     COST OF INSTALLATION INCLUDING MACHINE COSTS MINUS
C         TRANSMISSION LINE COSTS($)
      COSTIN=X(2)
C
C     COST OF TRANSMISSION LINES FROM MACHINE TO UTILITY
C         LINES($)
      TRANSC=X(3)
C
C     MARGINAL TAX RATE- INCLUDING STATE AND FEDERAL (%)
      MTAX=X(4)
C
C     NOMINAL BEFORE TAX DISCOUNT RATE (%)
      NOMDIS=X(5)
C
C     STATE INVESTMENT CREDIT (%)
      STATCR=X(6)
C
C     FEDERAL ENERGY CREDIT (%)
      FEDCR=X(7)
C
C     EXPECTED INFLATION RATE OVER LIFE OF MACHINE (%)
      INF=X(8)
C
C     ESCALATION RATE OF PAYMENTS BY UTILITY FOR ELECTRICITY
C          GENERATED BY MACHINE (%)
      ESCR=X(9)
C
C     INSTALLATION COSTS ($)
      ICOST=X(10)
C
C     DOLLARS PER KILOWATT HOUR UTILITY PAYS FOR GENERATED
C          ELECTRICITY ($/KWH)
      ELEPAY=X(11)
C
C     AVERAGE KILOWATT HOURS OF ELECTRICITY PRODUCED BY WIND
C          MACHINE PER YEAR (KWH/YR)
      POWER=X(12)
C
```

```
C
C     COST OF MACHINE INCLUDING TOWER AND METERS
      MHCOST=X(13)
C
C     FEDERAL INVESTMENT CREDIT (%)
      INVCR=X(14)
C
C     COMPUTE BEFORE TAX DISCOUNT RATE INCLUDING UTILITY
C         ESCALATION RATE USED IN ANNUITY DISCOUNT FACTOR
C         APPLIED IN PRESENT VALUE CALULATIONS OF REVENUE
C
      DIS1=((1.0+NOMDIS)/(1.0+ESCR))-1.0
C
C     COMPUTE BEFORE TAX DISCOUNT RATE INCLUDING INFLATION
C         RATE USED IN ANNUITY DISCOUNT FACTOR APPLIED TO
C         WIND COSTS
C
      DIS2=((1.0+NOMDIS)/(1.0+INF))-1.0
C
C     BEFORE TAX ADF FOR PRESENT VALUE REVENUE
C
      PVBT1=(1.0-(1.0+DIS1)**(-LIFE))/DIS1
C
C     BEFORE TAX ADF FOR REVENUE CALCULATIONS
C
      PVBT2=(1.0-(1.0+DIS2)**(-LIFE))/DIS2
C
C     COMPUTE AFTER TAX DISCOUNT RATE INCLUDING UTILITY
C          ESCALATION RATE USED IN ANNUITY DISCOUNT
C          FACTOR APPLIED TO PRESENT VALUE REVENUE
C
      TDIS=((1.0+NOMDIS*(1.0-MTAX))/(1.0+ESCR))-1.0
C
C     COMPUTE AFTER TAX DISCOUNT RATE INCLUDING EXPECTED
C          INFLATION RATE USED IN ANNUITY DISCOUNT FACTOR
C          APPLIED TO WIND  COSTS
C
      TDIS2=((1.0+NOMDIS*(1.0-MTAX))/(1.0+INF))-1.0
C
C     AFTER TAX ANNUITY DISCOUNT FACTOR (ADF) FOR REVENUE
      ADF=(1.0-(1.0+TDIS)**(-LIFE))/TDIS
C
C     AFTER TAX ANNUITY DISCOUNT FACTOR (ADF) FOR WIND COSTS
      ADFR=(1.0-(1.0+TDIS2)**(-LIFE))/TDIS2
C
C
      WRITE(6,900) (X(J),J=1,14)
  900 FORMAT(1X,5F12.5)
C
C
C     CALCULATE OPERATION AND MAINTENANCE COSTS PER YEAR
        CALL OMCOST(OMC,MHCOST,ADFR,PVOMC,MTAX,C,PVC,PVBT2)
C
```

```
C     CALCULATE DEPRECIATION USING ACRS METHOD ON FIVE YEAR PROPERTY
        CALL DEP(D,FEDCR,COSTIN,INVCR,SPVD,NOMDIS,MTAX,PVD)
C
C     DETERMINE GENERATED ELECTRICITY REVENUE EACH YEAR
        CALL REV(R,POWER,ELEPAY,ADF,PVREV,RR,INF,ESCR,MTAX,PVR,PVBT1)
C
C     DETERMINE CASH FLOW, BEFORE AND AFTER TAX AND NET PRESENT VALUE
        CALL CAFLOW(CF,R,SPVD,FEDCR,STATCR,INVCR,COSTIN,NPVT
     *,NPV,PVREV,PVOMC,D,OMC,NOMDIS,FC,IC,SC,TC,RR,RCFT,MTAX
     *,C,PVC,PVR)
C
C
C     OUTPUT RESULTS
        CALL OUT(COSTIN,TRANSC,STATCR,FEDCR,
     *   INF,ELEPAY,POWER,MHCOST,INVCR,ESCR,OMC,D,R,
     *   CF,NPVT,NPV,MTAX,NOMDIS,ADFR,ADF,PVOMC,PVREV,
     *   SPVD,FC,IC,SC,TC,RR,ICOST,RCFT,PVC,PVBT1,PVBT2,C,PVR)
C
      STOP
      END
C
C
C     CALCULATE O&M COSTS PER YEAR
C
      SUBROUTINE OMCOST(OMC,MHCOST,ADFR,PVOMC,MTAX,C,PVC,PVBT2)
      IMPLICIT REAL(A-Z)
      DIMENSION OMC(30),C(30)
      INTEGER LIFE,I,J
      COMMON LIFE
      DO 10 I=1,LIFE
        OMC(I)=0.05*MHCOST*(1.0-MTAX)
        C(I)=0.05*MHCOST
 10   CONTINUE
C
C     PRESENT VALUE OF O&M COSTS
      PVOMC=ADFR*OMC(1)
      PVC=PVBT2*C(1)
      RETURN
      END
C
C
C     CALCULATE DEPRECIATION
C
      SUBROUTINE DEP(D,FEDCR,COSTIN,INVCR,SPVD,NOMDIS,MTAX,PVD)
      IMPLICIT REAL(A-Z)
      DIMENSION D(30),PVD(30)
      INTEGER LIFE,I,J
      COMMON LIFE
      DEPMC=COSTIN-0.5*(INVCR*COSTIN+FEDCR*COSTIN)
      D(1)=0.15*DEPMC
      D(2)=0.22*DEPMC
      D(3)=0.21*DEPMC
      D(4)=0.21*DEPMC
      D(5)=0.21*DEPMC
C
```

```
C     PRESENT VALUE OF DEPRECIATION FOR EACH YEAR
      PVD(1)=D(1)/(1.0+NOMDIS*(1.0-MTAX))
      PVD(2)=D(2)/(1.0+NOMDIS*(1.0-MTAX))**2
      PVD(3)=D(3)/(1.0+NOMDIS*(1.0-MTAX))**3
      PVD(4)=D(4)/(1.0+NOMDIS*(1.0-MTAX))**4
      PVD(5)=D(5)/(1.0+NOMDIS*(1.0-MTAX))**5
C
C     TOTAL OF PRESENT VALUE DEPRECIATION BENEFITS
      SPVD=(PVD(1)+PVD(2)+PVD(3)+PVD(4)+PVD(5))*MTAX
       DO 10 I=6,LIFE
         D(I)=0.0
 10    CONTINUE
      RETURN
      END
C
C
C     DETERMINE REVENUE GENERATED EACH YEAR
C
      SUBROUTINE REV(R,POWER,ELEPAY,ADF,PVREV,RR,INF,ESCR,MTAX,
     *PVR,PVBT1)
      IMPLICIT REAL(A-Z)
      DIMENSION R(30),RR(30)
      INTEGER LIFE,I,J
      COMMON LIFE
      DO 10 I=1,LIFE
       R(I)=(POWER*ELEPAY*(1.0+ESCR)**I)/(1.0+INF)**I
       RR(I)=((POWER*ELEPAY*(1.0+ESCR)**I)/(1.0+INF)**I)*(1.0-
     *MTAX)
 10   CONTINUE
C
C     PRESENT VALUE OF REVENUE
      PVREV=ADF*RR(1)*(1.0+INF)/(1.0+ESCR)
      PVR=PVBT1*R(1)*(1.0+INF)/(1.0+ESCR)
      RETURN
      END
C
C     DETERMINE BEFORE AND AFTER TAX CASH FLOW
C
      SUBROUTINE CAFLOW(CF,R,SPVD,FEDCR,STATCR,INVCR,COSTIN,NPVT,
     *NPV,PVREV,PVOMC,D,OMC,NOMDIS,FC,IC,SC,TC,RR,RCFT,MTAX,
     *C,PVC,PVR)
      IMPLICIT REAL(A-Z)
      DIMENSION CF(30),R(30),D(30),OMC(30),RR(30),
     *RCFT(30),C(30)
      INTEGER LIFE,I,J
      COMMON LIFE
C
C     CF IS THE CASH FLOW BEFORE TAX
      CF(0)=-COSTIN
C     RCFT IS THE CASH FLOW AFTER TAX
      RCFT(0)=-COSTIN
```

```
C
C     DETERMINE AMOUNTS OF THE VARIOUS TAX CREDITS
      FC=FEDCR*COSTIN
      IC=INVCR*COSTIN
      SC=STATCR*(FC+IC)
C     CHECK IF STATE CREDIT IS LARGER THAN MAXIMUM OF
C           $500.00 ALLOWED
      IF(SC.GT.500.00) SC=500.00
      CF(1)=R(1)-C(1)
      RCFT(1)=RR(1)-OMC(1)+FC+IC+SC+D(1)
      DO 10 I=2,LIFE
       CF(I)=R(I)-C(I)
       RCFT(I)=RR(I)-OMC(I)+D(I)
   10 CONTINUE
C
C     PRESENT VALUE OF TOTAL CREDITS ALLOWED
      TC=(FC+IC+SC)/(1.0+NOMDIS*(1.0-MTAX))
C
C     NET PRESENT VALUE AFTER TAX CASH FLOW
      NPVT=(-COSTIN)+PVREV-PVOMC+TC+SPVD
C
C     NET PRESENT VALUE BEFORE TAX CASH FLOW
      NPV=(-COSTIN)+PVR-PVC
      RETURN
      END
C
C
C     PRINT RESULTS
C
      SUBROUTINE OUT(COSTIN,TRANSC,STATCR,
     *FEDCR,INF,ELEPAY,POWER,MHCOST,INVCR,ESCR,OMC,
     *D,R,CF,NPVT,NPV,MTAX,NOMDIS,ADFR,ADF,PVOMC,PVREV,
     *SPVD,FC,IC,SC,TC,RR,ICOST,RCFT,PVC,PVBT1,PVBT2,C,PVR)
      IMPLICIT REAL(A-Z)
      DIMENSION OMC(30),D(30),R(30),CF(30),RR(30),C(30)
     *,RCFT(30)
      INTEGER LIFE,I,J
      COMMON LIFE
      WRITE(6,100)
  100 FORMAT(1X,'------------------------INITIAL VARIABLES------')
      WRITE(6,101)LIFE
  101 FORMAT(1X,'YEARS OF SWECS LIFE=',I2)
      WRITE(6,102)MHCOST
  102 FORMAT(1X,'COST OF MACHINE=$',F12.2)
      WRITE(6,103)TRANSC
  103 FORMAT(1X,'TRANSMISSION LINE COSTS=$',F12.2)
      WRITE(6,104)ICOST
  104 FORMAT(1X,'INSTALLATION COSTS=$',F12.2)
      WRITE(6,320)COSTIN
  320 FORMAT(1X,'TOTAL COSTS OF WIND MACHINE INVESTMENT=$',F12.2)
      WRITE(6,105) MTAX
  105 FORMAT(1X,'MARGINAL TAX RATE ON ADDITIONAL INCOME=$',F12.3)
      WRITE(6,106) NOMDIS
```

```
106   FORMAT(1X,'NOMINAL BEFORE TAX DISCOUNT RATE=$',F12.3)
      WRITE(6,109) STATCR
109   FORMAT(1X,'STATE INVESTMENT TAX CREDIT=',F12.3)
      WRITE(6,110) FEDCR
110   FORMAT(1X,'FEDERAL ENERGY TAX CREDIT=',F12.3)
      WRITE(6,111) INVCR
111   FORMAT(1X,'FEDERAL INVESTMENT CREDIT=',F12.3)
      WRITE(6,113) INF
113   FORMAT(1X,'EXPECTED INFLATION RATE=',F12.3)
      WRITE(6,121) POWER
121   FORMAT(1X,'ENERGY GENERATED BY MACHINE (KWH/YEAR) =$',F12.2)
      WRITE(6,122) ELEPAY
122   FORMAT(1X,'PAYMENT BY UTILITY FOR GENERATED ELEC(KWH)=$',F12.4)
      WRITE(6,124) ESCR
124   FORMAT(1X,'ESCALATION RATE FOR PRICE PAID BY UTILITY=',F12.4)
      WRITE(6,200) SALVAL
200   FORMAT(1X,'SALVAGE VALUE OF MACHINE=$',F12.2)
      WRITE(6,125)
125   FORMAT(///,T18,'ECONOMIC ANALYSIS')
      WRITE(6,114)
114   FORMAT(T18,'IN CURRENT(1984) $')
      WRITE(6,300)
300   FORMAT(1X,'-----------------------------------------------',/)
      WRITE(6,126)
126   FORMAT(///,T2,'YEAR',T12,'O&M COSTS',T26,'DEPRECIATION',T42,
     *'REVENUE',/)
      DO 10 I=1,LIFE
      WRITE(6,127) I,OMC(I),D(I),RR(I)
127   FORMAT(T3,I2,T12,F8.2,T28,F8.2,T41,F8.2)
10    CONTINUE
      WRITE(6,130)
130   FORMAT(///,T25,'CASH FLOW')
      WRITE(6,115)
115   FORMAT(T20,'IN CURRENT(1984) $')
      WRITE(6,300)
      WRITE(6,131)
131   FORMAT(/,T2,'YEAR',T11,'BEFORE TAX',T27,'AFTER TAX',/)
      DO 30 I=0,LIFE
      WRITE(6,132)I,CF(I),RCFT(I)
132   FORMAT(T2,I2,T12,F9.2,T27,F9.2)
30    CONTINUE
      WRITE(6,400) PVBT1
400   FORMAT(//,' ','BEFORE TAX ADF FOR REVENUE(%)=',F9.4)
      WRITE(6,410) PVBT2
410   FORMAT(/,' ','BEFORE TAX ADF FOR WIND O&M COSTS(%)=',F9.4)
      WRITE(6,150) ADF
150   FORMAT(/,' ','AFTER TAX ADF APPLIED TO REVENUE(%)=',F9.4)
      WRITE(6,151)ADFR
151   FORMAT(/,' ','AFTER TAX ADF APPLIED TO O&M COSTS(%)=',F9.4)
      WRITE(6,440) PVC
440   FORMAT(/,' ','BEFORE TAX PRESENT VALUE COSTS=$',F12.2)
      WRITE(6,450) PVR
450   FORMAT(/,' ','BEFORE TAX PRESENT VALUE REVENUE=$',F12.2)
      WRITE(6,152)PVREV
```

```
  152 FORMAT(/,' ','AFTER TAX PRESENT VALUE OF REVENUE=$',F12.2)
      WRITE(6,153) PVOMC
  153 FORMAT(/,' ','AFTER TAX PRESENT VALUE O&M COSTS=$',F12.2)
      WRITE(6,154) SPVD
  154 FORMAT(/,' ','PR`SENT VALUE OF TOTAL DEPRECIATION=$',F12.2)
      WRITE(6,155) FC
  155 FORMAT(/,' ','FEDERAL ENERGY TAX CREDIT RECEIVED=$',F9.2)
      WRITE(6,156) IC
  156 FORMAT(/,' ','FEDERAL INVESTMENT TAX CREDIT RECEIVED=$',F9.2)
      WRITE(6,157) SC
  157 FORMAT(/,' ','STATE INVESTMENT TAX CREDIT RECEIVED=$',F9.2)
      WRITE(6.158) TC
  158 FORMAT(/,' ','PRESENT VALUE OF TOTAL INVESTMENT CREDIT=$',F9.2)
      WRITE(6,136)NPV
  136 FORMAT(//,' ','NET PRESENT VALUE BEFORE TAX=$',F12.2)
      WRITE(6,137) NPVT
  137 FORMAT(//,' ','NET PRESENT VALUE AFTER TAX=$',F12.2)
C
C     CALCULATE AFTER TAX BREAK EVEN PRICE
      OPT=-(-COSTIN-PVOMC+TC+SPVD)/(ADF*POWER)
C
C     CALCULATE BEFORE TAX BREAK EVEN PRICE
      OP=-(-COSTIN-PVC)/(PVBT1*POWER)
C
      WRITE(6,330)OP
  330 FORMAT(1X,/,'BEFORE TAX BREAK EVEN PRICE=$',F9.4)
      WRITE(6,340) OPT
  340 FORMAT(1X,/,'AFTER TAX BREAK EVEN PRICE=$',F9.4)
      RETURN
      END
```

APPENDIX B

Sample run of

FORTRAN

Program

```
   20.00000 25500.00000      .00000      .40000      .12000
     .05000      .15000      .07000      .07500      .00000
     .06500 17500.00000 22500.00000      .10000
-----------------------INITIAL VARIABLES------
YEARS OF SWECS LIFE=20
COST OF MACHINE=$    22500.00
TRANSMISSION LINE COSTS=$          .00
INSTALLATION COSTS=$          .00
TOTAL COSTS OF WIND MACHINE INVESTMENT=$    25500.00
MARGINAL TAX RATE ON ADDITIONAL INCOME=$        .400
NOMINAL BEFORE TAX DISCOUNT RATE=$        .120
STATE INVESTMENT TAX CREDIT=        .050
FEDERAL ENERGY TAX CREDIT=        .150
FEDERAL INVESTMENT CREDIT=        .100
EXPECTED INFLATION RATE=        .070
ENERGY GENERATED BY MACHINE (KWH/YEAR) =$    17500.00
PAYMENT BY UTILITY FOR GENERATED ELEC(KWH)=$        .0650
ESCALATION RATE FOR PRICE PAID BY UTILITY=        .0750
SALVAGE VALUE OF MACHINE=$          .00
```

ECONOMIC ANALYSIS
IN CURRENT(1984) $

YEAR	O&M COSTS	DEPRECIATION	REVENUE
1	675.00	3346.88	685.69
2	675.00	4908.75	688.89
3	675.00	4685.63	692.11
4	675.00	4685.63	695.35
5	675.00	4685.63	698.60
6	675.00	.00	701.86
7	675.00	.00	705.14
8	675.00	.00	708.44
9	675.00	.00	711.75
10	675.00	.00	715.07
11	675.00	.00	718.41
12	675.00	.00	721.77
13	675.00	.00	725.14
14	675.00	.00	728.53
15	675.00	.00	731.94
16	675.00	.00	735.36
17	675.00	.00	738.79
18	675.00	.00	742.24
19	675.00	.00	745.71
20	675.00	.00	749.20

CASH FLOW
IN CURRENT(1984) $

YEAR	BEFORE TAX	AFTER TAX
0	-25500.00	-25500.00
1	17.82	10051.31
2	23.16	4922.64
3	28.52	4702.74
4	33.91	4705.97
5	39.33	4709.22
6	44.77	26.86
7	50.23	30.14
8	55.73	33.44
9	61.24	36.75
10	66.79	40.07
11	72.35	43.41
12	77.95	46.77
13	83.57	50.14
14	89.22	53.53
15	94.89	56.94
16	100.59	60.36
17	106.32	63.79
18	112.07	67.24
19	117.85	70.71
20	123.66	74.20

BEFORE TAX ADF FOR REVENUE(%)= 13.3692

BEFORE TAX ADF FOR WIND O&M COSTS(%)= 12.8152

AFTER TAX ADF APPLIED TO REVENUE(%)= 20.5982

AFTER TAX ADF APPLIED TO O&M COSTS(%)= 19.6133

BEFORE TAX PRESENT VALUE COSTS=$ 14417.13

BEFORE TAX PRESENT VALUE REVENUE=$ 15207.41

AFTER TAX PRESENT VALUE OF REVENUE=$ 14058.24

AFTER TAX PRESENT VALUE O&M COSTS=$ 13238.95

PRESENT VALUE OF TOTAL DEPRECIATION=$ 7221.95

FEDERAL ENERGY TAX CREDIT RECEIVED=$ 3825.00

FEDERAL INVESTMENT TAX CREDIT RECEIVED=$ 2550.00

STATE INVESTMENT TAX CREDIT RECEIVED=$ 318.75

PRESENT VALUE OF TOTAL INVESTMENT CREDIT=$ 6244.17

NET PRESENT VALUE BEFORE TAX=$ -24709.71

NET PRESENT VALUE AFTER TAX=$ -11214.60

BEFORE TAX BREAK EVEN PRICE=$ .1706

AFTER TAX BREAK EVEN PRICE=$ .0701